

REMARKS

This paper is in response to the Advisory Action of January 24, 2007. Claims 1-3, 5-7, 9, and 21-24 are pending in this application. Applicants have amended the application as set forth above. Specifically, Claim 1 has been amended. No new matter is added by the amendment as discussed below. Applicants respectfully request the entry of the amendment and reconsideration of the application in view of the above amendment and the following remarks.

Discussion of Amendment

The amendment to Claim 1 is made to further clarify that a Ru/Re layer is formed *directly* on a surface of an insulation layer. Support for the amendment to Claim 1 can be found in, for example, Figure 2A and paragraph 0022 of Patent Application Publication No. 2005/0124154 of the subject application. Specifically, paragraph 0022 states that “*Also, ruthenium (Ru) or rhenium (Re), which have property of immiscibility with copper material and also of mechanically very strong material, can be used as a barrier layer 230a according to the present invention.*” In Figure 2A, the barrier layer 230a is depicted as being *directly* on an insulating layer 210a.

As such, contrary to the doubts expressed by the Examiner in the Advisory Action, Applicants respectfully submit that the amendment to Claim 1 is fully supported by the application as originally filed and does not constitute the addition of new matter. Therefore, Applicants respectfully request the entry of the amendment.

Discussion of Advisory Action

In response to the final Office Action of November 13, 2006, Applicants filed a Response on January 10, 2007, asserting that the Office Action failed to establish a *prima facie* case of obviousness for Claims 1-3, 5-7, 9, and 21-24 while canceling Claims 10-13, 15-17, and 25-28. Among other things, Applicants stated that Soininen et al. and Toyoda et al., individually or in combination, fail to teach or suggest all the limitations of Claim 1. Particularly, Applicants asserted that the prior art references do not teach or suggest Ru/Re usage as a barrier to Cu diffusion *directly* on the surface of the insulation layer. In response to the Applicants' Response, the Advisory Action was issued on January 24, 2007, maintaining the rejection of Claims 1-3, 5-7, 9, and 21-24.

I. CLAIM 1 HAS BEEN AMENDED TO CLARIFY THAT Ru/Re IS FORMED DIRECTLY ON A SURFACE OF AN INSULATION LAYER AND CLAIM 1 IS FULLY SUPPORTED BY THE SPECIFICATION.

In the Advisory Action of January 24, 2007, the Examiner asserted in paragraph 2 that the current language in Claim 1 is not limited to “directly on” and also questioned whether the specification has support for Claim 1. Applicants respectfully submit that Claim 1 has been amended as set forth above to clarify that a barrier layer is formed using ruthenium (Ru) or rhenium (Re) or their alloys *directly on* a surface of an insulation layer. In addition, the amendment to Claim 1 is fully supported by the specification as discussed above in the Discussion of Amendment section.

II. THE INHERENT CHARACTERISTIC OF Ru/Re DOES NOT MAKE THE COMBINATION OF CLAIM 1 OBVIOUS.

The Advisory Action states in paragraph 4 that “Applicant argues, ‘although Ru or RuO₂ is used adjacent to an insulation layer, it is not used as a barrier against copper diffusion.’ *The inherent characteristic* of those materials has that conduct/behavior.” In addition, the Advisory Action states in paragraph 5 that “Applicant argues ‘Toyoda et al. does not cure this deficiency because it also fails to disclose forming barrier layer using Ru or Re on a surface of an insulation layer, as recited in Claim 1 because Toyoda et al. does not disclose a ruthenium layer formed directly on a surface of an insulator.’ The response is the same as in the above.” Applicants, however, respectfully disagree with the Examiner for the reasons as set forth below.

A. The Inherent Characteristic Of Ru Does Not Suggest That Ru Can Serve As A Copper Barrier Directly on An Insulator.

The inherent characteristic of Ru does not suggest that Ru can serve as a copper barrier

directly on an insulator. The damascene embodiment of Soininen et al. (applied by the Examiner) expressly includes a metal nitride layer 14 between the insulator 8, 12 and the seed layer 16.

Even if the Examiner's finding that copper diffusion would inherently be prevented by the Ru of Soininen et al. is accepted, that does not give the skilled artisan any reason to use Ru directly on an insulator in the context of Toyoda et al. Thus, the skilled artisan would not be taught to *omit* the TaN 14 of Soininen et al., or TaN 34 of Toyoda et al. to meet the claimed direct contact.

B. The Inherent Characteristic Of Ru Does Not Suggest That Ru Should Serve As A Copper Barrier Directly On An Insulation Layer Because There Is No Ru Layer Directly On The Insulation Layer Of The Dual Damascene Structure Of Soininen Et Al.

The inherent characteristic of Ru does not suggest that Ru should serve as a copper barrier directly on an insulation layer because there is no Ru layer directly on the insulation layer of the dual damascene structure of Soininen et al. Toyoda et al. does not cure this deficiency because it also fails to disclose Ru directly on an insulation layer.

In re Mills states "We are here, however, facing an obviousness issue. It is not pertinent whether the prior art device [inherently] possesses the functional characteristics of the claimed invention if the reference does not describe or suggest its structure." *In re Mills*, 916 F.2d 680, 683, 16 USPQ.2d 1430, 1432 (Fed. Cir. 1990). *In re Rijckaert* states that "Such a retrospective view of inherency is not a substitute for some teaching or suggestion supporting an obviousness rejection. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ.2d 1955, 1957 (Fed. Cir. 1993). *In re Rijckaert* also states that "That which may be inherent is not necessarily known. Obviousness cannot be predicated on what is unknown." *See id.* (internal quotes omitted).

Soininen et al. discloses a dual damascene structure. Soininen et al., Figure 1 below. The dual damascene structure consists of a metallization layer 2, e.g., Cu, an insulating layer 4, e.g., SiO₂, a via etch stop 6 made of, e.g., Si₃N₄, a via level insulator 8, e.g., SiO₂, a trench etch stop 10 made of, e.g., Si₃N₄, a trench level insulator 12, e.g., SiO₂, a diffusion barrier 14, e.g., TaN, a seed layer 16 (e.g., metal oxides such as ReO₂ and RuO₂) and a via/trench fill metal 18, e.g., Cu.

See *id.* at Figure 1; column 5, lines 46-52; column 6, lines 43-53; and column 7, lines 21-37.

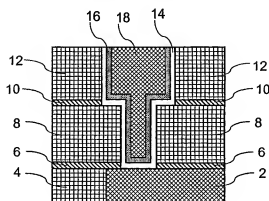


Fig. 1

The inherent (not express, i.e., “unknown”) characteristic of Ru does nothing to suggest providing the Ru layer 16 *directly* on the insulators 8, 12 in a copper damascene context. Persons of ordinary skill may recognize that the Ru seed layer 16 can be used at the position shown in Figure 1 of Soininen et al. However, nothing in the art suggests omitting Soininen’s metal nitride layer 14 from between the Ru 16 and the insulator 8, 12.

Toyoda et al. does not cure this deficiency because it also fails to disclose “forming a barrier layer using Ru or Re *directly* on a surface of an insulation layer,” as recited in Claim 1 as amended. The structure shown in Figure 3E of Toyoda et al. does not have a ruthenium layer formed *directly* on a surface of an insulator. See Toyoda et al., Figure 3E below; and paragraph [0138]. Like the damascene embodiment of Soininen et al., Toyoda et al. only discloses a ruthenium layer 37 formed on a surface of a conductive layer 34 (a first barrier layer), not on a surface of the underlying insulation layer. See *id.* In addition, while stating that ruthenium can help to prevent Cu diffusion, Toyoda et al. does not suggest its use without intervening metal nitride. Rather, Toyoda et al. explicitly states that the ruthenium layer serves as a *second barrier layer*. Therefore, the inherent characteristic of Ru does not provide that Ru can serve as a copper barrier *directly* on an insulation layer, without intervening metal nitride, even accepting that Soininen et al. and Toyoda et al are fair to combine.

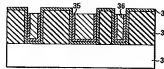


FIG. 3D

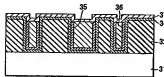


FIG. 3E

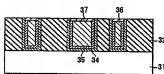


FIG. 3F

As set forth above, even with the inherent characteristic of Ru, Soininen et al., and Toyoda et al., either individually or in combination, fail to teach or suggest all the limitations of Claim 1 as amended. Thus, the Office Action fails to establish a *prima facie* case of obviousness. Therefore, Claim 1 is allowable under 35 U.S.C. 103(a) over Soininen et al. in combination with Toyoda et al. Claims 6 and 7 depend directly or indirectly from Claim 1, and are allowable for substantially the same reasons as explained above.

III. OTHER CLAIMS ARE PATENTABLE BECAUSE THEY DEPEND FROM CLAIM 1.

Claims 2, 3, 5, and 9

With respect to Claims 2, 3, 5, and 9, Applicants submit that the Office Action fails to establish a *prima facie* case of obviousness. Soininen et al., Toyoda et al., Kim et al., and Koh et al., either alone or in combination, do not teach or suggest all the limitations of the claims.

Claims 2, 3, 5, and 9 depend directly from Claim 1. As set forth above, Soininen et al. and Toyoda et al., either individually or in combination, fail to teach or suggest all the limitations of

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Claim 1. Kim et al. and Koh et al., either individually or in combination, fail to cure this deficiency. Neither of these two references teaches or suggests “forming a barrier layer using Ru or Re *directly on a surface of an insulation layer*,” as recited in Claim 1 as amended. Therefore, Claims 2, 3, 5, and 9 are allowable under 35 U.S.C. 103(a) over Soininen et al. and Toyoda et al. and further in view of Kim et al. and Koh et al.

Claims 12, 13, 15, and 25-28

Claims 12, 13, 15, and 25-28 were previously canceled by the Amendments filed on January 10, 2007, rendering the rejection of these claims moot.

Claims 21-24

With respect to Claims 21-24, Applicants submit that the Office Action fails to establish a *prima facie* case of obviousness. Soininen et al., Toyoda et al., and Gelatos et al., either alone or in combination, do not teach or suggest all the limitations of the claims.

Claims 21-24 depend directly or indirectly from Claim 1. As set forth above, Soininen et al. and Toyoda et al., either alone or in combination, fail to teach or suggest all the limitations of Claim 1. Gelatos et al. does not cure this deficiency because it fails to disclose “forming a barrier layer using Ru or Re *directly on a surface of an insulation layer*,” as recited in Claim 1 as amended. Therefore, Claims 21-24 are allowable under 35 U.S.C. 103(a) over Soininen et al. in combination with Toyoda et al. and further in view of Gelatos et al.

Discussion of Rejection Under 35 U.S.C. § 102

In the final Office Action of November 13, 2006, the Examiner rejected Claims 10, 11, 16, and 17 under 35 U.S.C. § 102 (a) as being anticipated by Soininen et al. (U.S. Patent No. 6,482,740). As mentioned above, Claims 10, 11, 16, and 17 were canceled by the Amendments filed on January 10, 2007, rendering the rejection of these claims moot.

For all of these reasons, Applicants respectfully request withdrawal of this rejection, and allowance of the pending claims.

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CONCLUSION

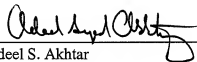
In view of Applicants' amendment to the claims and the foregoing remarks, Applicants respectfully submit that the present application is in condition for allowance. Should the Examiner have any remaining concerns, which might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number appearing below.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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